Improvements in or relating to the aggregation of soils

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Abstract of **GB907182**

Soil is aggregated by adding thereto a partially saponified polyvinyl acetate of a degree of saponification of 75 to 95 mol per cent of a degree of polymerization of at least 500. The polymer may be added in powder form directly to the soil, or it may first be mixed with gravel, cement, lime or a fertilizer or mixture thereof. Alternatively the polymer may be added to the soil at the same time as sand, limestone, lime, fertilizers, e.g. ammonium sulphate, or trace elements.

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COMPLETE SPECIFICATION.

Improvements in or relating to the Aggregation of Soils.

We, SHIN-ETSU KAGAKU KOGYO KABUSHIKI KAISHA, of No. 2, 1-Chome, Marunouchi, Chiyoda-Ky, Tokyo-To, Japan, a Japanese Joint Stock Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

This invention relates to the improvement of soils, and more particularly it relates to a new and practical method of improving soils by aggregation thereof.

In general, the usefulness of soil is mostly influenced by its physical structure. In the case of fertile soils, since they have physically aggregated structures, air and water are preserved to a suitable content within the spaces between the soil grains, and, as they fill up the non-capillary pores, excessive moisture loss due to evaporation is prevented, cracks in the soil due to drying do not develop, and the optimum proportions of moisture and air necessary for the growth of plants are preserved for a long time. Barren soils, on the other hand, have a single grained structure and have almost no non-capillary pores. Consequently, these soils quickly become muddy under rain, and excessive water flows along the ground surface, washing away fine grains of soil. As a result, the soils are rapidly eroded. Moreover, when they become dry, their surface layers harden and develop cracks, and the moisture in the soils is rapidly evaporated away. Consequently, lack of air and water which are necessary for the growth of plants results, and the agricultural value of the soil is greatly reduced.

In the regions of the world where barren soils exist over large areas, for example, in Japan, the increasing of the utility of the soil by the improvement through aggregation of its physical structure is an acute problem. Accordingly, this problem has been studied for a long time from various aspects, and several methods have hitherto been proposed, particularly methods depending on the addition of such synthetic products as anion polyelectrolytes. However, since the methods proposed heretofore have suffered from disadvantages such as excessive cost or short duration of effectiveness, no practical method has yet been found.

Among the methods proposed is the use of polyvinyl alcohol as an additive. Invariably, however, this polyvinyl alcohol is a completely saponified product and does not contain acetyl residues, in which case, since the aggregation effect is extremely weak, this compound has not yet been put to practical use as an additive.

It is an object of the present invention to provide a new and practical method of improving the physical structure of soils by aggregation thereof, whereby natural erosion of the soil may be prevented and the yield of plant crops therefrom may be increased.

It is another object of the invention to provide a method as stated above which, moreover, is not accompanied by the disadvantages of and is superior to the known methods proposed heretofore. More specifically, it is an object of the invention to provide a method as stated above which has the advantages of simplicity of application, low cost, and long duration of effectiveness.

The mechanism of aggregation of soil caused by addition of synthetic products is believed to be generally as follows. These synthetic products dissolve in water, thus causing adhesion of soil grains. These adhering soil grains are converted into an insoluble state with the lapse of time, whereby a waterproof aggregated structure is formed.

[*Price* 4*s.* 6*d.*]

Polyvinyl alcohol is very difficult to dissolve in water in practice, and when it contacts water it is converted rapidly into an insoluble state. Consequently even when polyvinyl alcohol is added to soil, the part of the polyvinyl alcohol participating in the aggregation of soil grains is very small, thus reducing the aggregating effect.

The inventors of this invention have discovered, after various studies in connection with various kinds of polyvinyl compounds to overcome the above-mentioned disadvantage, that partially saponified polyvinyl acetate, of a certain degree of saponification and degree of polymerization such that it is intrinsically soluble in cold water, exhibits a remarkably high aggregating effect.

A method according to the present invention of aggregating soil thus comprises adding to the soil a partially saponified polyvinyl acetate of 75 to 95, and preferably 80 to 90, mol per cent degree of saponification, and of at least 500, and preferably at least 1000, degree of polymerization.

When such a partially saponified polyvinyl acetate is added in its solid state to soil of single grained structure, it couples with the grains of the soil with water as a medium and forms a water-stable aggregated structure. Moreover, since the resulting structure is maintained unchanged for a long time, the present invention affords a method whereby the structure of the soil, particularly barren soil, can be rapidly improved, thereby preventing erosion of the soil and providing the soil with favourable conditions for the growth of plants.

The quantity of the said partially saponified polyvinyl acetate to be added to the soil varies with the properties of the soil to be so treated, but, in general, a percentage relative to the weight of the surface soil of from 0.005 to 2 per cent, especially 0.05 per cent or higher, is suitable.

The method of the present invention may be applied by adding partially saponified polyvinyl acetate in powdered form directly to the soil, and ploughing and cultivating the soil. In this case, the further addition of sand, limestone, mineral fertilizers, and other soil-fertilizing materials or solid carriers, and diluents, such as soil-improvement substances, for example, portland cement may be carried out at will. However, if together with these substances, trace elements such as boron, manganese, and magnesium are added simultaneously, it will be possible to obtain a distinct improvement in crop growth and yield as compared to the results obtainable if these substances were to be added independently.

In an advantageous manner of carrying out the invention, the partially saponified polyvinyl acetate is first mixed with gravel or cement as a diluent, before addition to the soil; lime or a mineral fertilizer may alternatively or also be thus mixed with the partially saponified polyvinyl alcohol. After addition of the mixture, the soil may be ploughed and cultivated.

The details of the effectiveness of the method of the present invention will be more clearly apparent from a consideration of the following examples.

EXAMPLE 1.

To heavy clay (substratum soil) of the Tomioka district of Gumma Prefecture, Japan, 0.1 per cent (on the basis of dry soil weight) of each of several kinds of polyvinyl alcohols and partially saponified polyvinyl acetates was added directly as powder and mixed well with the said soil. Then the distribution of water-stable aggregates was measured by a D.I.K. type aggregate analyser (see the Bulletin of the Nat. Inst. of Agricultural Sciences (Japan), Series B, No. 7, February 1957); the soil aggregates were fractionated into 6 fractions by aggregate size, as listed at the head of the following Table I. The results obtained, as indicated in Table I, show a conspicuous aggregated distribution in the case of partially saponified polyvinyl acetate of degree of polymerization of 500 or higher.

TABLE 1.
Result of experiment described in Example 1.

	Water stable aggregate.					
	> 2 mm.	> 1 mm.	>0.5 mm.	>0.2 mm.	>0.1 mm.	>0.1 mm.
Untreated Soil	0%	0.5%	19.2%	25.1%	18.9%	36.3%
Soil treated with polyvinyl alcohol polymerized at low temperature (0° C.) (degree of polymerization : 1,700) ..	0	0.8	17.9	25.0	21.6	34.7
Soil treated with unsaponified polyvinyl alcohol (degree of polymerization : 1,700) ..	0	0.8	18.85	26.6	20.15	33.6
Soil treated with unsaponified polyvinyl alcohol (degree of polymerization : 2,000) ..	0	0.5	19.25	25.85	25.1	29.3
Soil treated with partially saponified polyvinyl acetate (degree of saponification : 88 mol %, degree of polymerization : 1,700)	1.0	10.1	34.3	26.6	14.0	14.0
Soil treated with partially saponified polyvinyl acetate (degree of saponification : 88 mol %, degree of polymerization : 2,000)	2.1	15.4	35.0	23.2	14.2	10.1
Soil treated with partially saponified polyvinyl acetate (degree of saponification : 88 mol %, degree of polymerization : 500)	0	0.5	25.5	28.7	20.3	25.0

EXAMPLE 2.

To heavy clay (substratum soil) of the Tomioka district of Gumma Prefecture, Japan, each of several kinds of polyvinyl alchols and partially saponified polyvinyl acetates, of varying additive quantities, was added and mixed well with the said soil. Then the distribution of water-stable aggregates was measured by the same analyser as in Example 1. The results obtained, as indicated in the accompanying Table 2, show that, for the same additive quantity, the higher the degree of polymerization of the partially saponified polyvinyl acetate is, the greater is the aggregating effectiveness, and that, in the cases wherein the additive quantity exceeds 0.1 per cent, the said effectiveness is especially increased.

TABLE 2.

Result of experiment described in Example 2.

	Quantity added %	Water stable aggregates.					
		>2 mm.	>1 mm.	>0.5 mm.	>0.2 mm.	>0.1 mm.	>0.1 mm.
Untreated soil		0.1%	12.1%	18.5%	21.3%	18.9%	29.1%
Soil treated with polyvinyl alcohol (degree of polymerization : 2,000)	0.5	0.2	11.1	19.5	22.8	19.5	26.9
	0.1	0.4	13.0	19.4	23.1	19.95	24.15
	0.2	0.3	13.1	22.05	26.25	18.2	20.1
Soil treated with partially saponified polyvinyl acetate (degree of saponification : 88 mol %, degree of polymerization : 2,000)	0.05	2.9	16.9	26.1	24.0	14.2	15.9
	0.1	7.0	26.8	26.1	19.7	11.3	9.1
	0 2	21.5	36.9	26.5	9.5	3.6	2.0
Soil treated with partially saponified polyvinyl acetate (degree of saponification : 88 mol %, degree of polymerization : 500)	0.05	0.1	11.1	20.2	21.8	21.5	25.3
	0.1	0.5	10.8	22.3	25.5	20.0	20.9
	0.2	0.3	12.6	23.3	30.0	17.8	16.0
Soil treated with partially saponified polyvinyl acetate (degree of saponification : 88 mol %, degree of polymerization : 1,700)	0.05	0.7	14.2	31.5	27.1	14.6	11.9
	0.2	2.2	21.9	38.1	23.6	9.2	5.0
Soil treated with partially saponified polyvinyl acetate (degree of saponification : 88 mol %, degree of polymerization : 1,500)	0.05	1.6	14.6	21.0	19.1	17.1	26.6
	0.1	4.9	19.8	23.7	19.3	15.1	17.2
	0.2	7.3	27.4	28.6	17.8	10.9	8.0

EXAMPLE 3.

Onto ploughed soil (heavy clay of the Tomioka district of Gumma Prefecture, Japan) partially saponified polyvinyl acetate of 88 per cent degree of saponification and 1,700 degree of polymerization was distributed uniformly with a proportion of one kilogram of said acetate per acre of soil surface and mixed well with the said soil. A portion of the soil thus treated was left without other additives, but to another portion of the soil thus treated, lime was added, and to still another portion of the said soil, ammonium sulfate was added. Then, in order to provide the said soil with suitable moisture, it was sprinkled with water and left for approximately one and a half days, after which tomato seedlings were planted in the soil with a distribution of 150 seedlings per acre of soil surface. The resulting yields were as shown in the following Table 3.

TABLE 3.

Condition of soil.	Increase in field.
Untreated soil	0%
Soil with partially saponified polyvinyl acetate	108%
Soil with partially saponified polyvinyl acetate plus lime (equal quantities of each additive) ..	104%
Soil with partially saponified polyvinyl acetate plus ammonium sulfate (equal quantities of each additive)	109%

WHAT WE CLAIM IS:—

1. A method of aggregating soil, which comprises adding thereto a partially saponified polyvinyl acetate of a degree of saponification of 75 to 95 mol per cent and of a degree of polymerization of at least 500.
2. A method according to Claim 1, in which the degree of saponification is 80 to 90 mol per cent.
3. A method according to Claim 1 or 2, in which the degree of polymerization is at least 1000.
4. A method according to Claim 1, 2 or 3, in which the partially saponified polyvinyl acetate is added in an amount of 0.0005% to 2% by weight of the soil.
5. A method according to Claim 4, in which the polyvinyl acetate is added in an amount of 0.05% to 2% by weight of the soil.
6. A method according to any preceding claim, in which the partially saponified polyvinyl acetate is mixed with gravel or cement as a diluent before addition to the soil.
7. A method according to any preceding claim, in which the partially saponified polyvinyl acetate is mixed with lime or a mineral fertilizer before addition to the soil.
8. A method according to any preceding claim, as hereinbefore described with reference to the examples.
9. Soil, when aggregated by a method according to any preceding claim.

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